MEMBERS' EVENING 2008

The second Members' Evening was held on 8th March 2008, when four presentations were made. The instructions to the presenters were simple: *show us your interests and infect us with your enthusiasm*. It is hoped that other members, whether amateur or professional, will continue the success of the Members' Evenings in future years.

The Thulean Basalt Province

Alan Dawn

In the late Cretaceous, North America and Greenland were attached to Eurasia as part of Laurasia which had separated from Gondwanaland in the break up of Pangaea. Then, at about 63 Ma, in the early Tertiary, the North Atlantic began to form with rifting between North America, Greenland and Western Europe accompanied by voluminous volcanism. The area which is now the Inner Hebrides (Skye, Mull, Rhum, Eigg and Muck) together with the Ardnamurchan Peninsula were buried under massive flows of flood basalts. The rifting developed across mantle plumes (or hotspots), one of which lies beneath Iceland today. The previous track of this plume is traced by the Iceland - Faroes Ridge, with the basalts younging closer to Iceland, leaving the Faroes an inactive site. Above its hotspot, Iceland has been created by continuous volcanism since early Miocene times, c16 Ma. The island nation lies on the mid-ocean North Atlantic Ridge, and this is the only part of the currently active ridge exposed on land.

Water, ice and volcano interactions

There are various interactions between volcanoes and the ice fields. The largest ice field is Vatnajokul, in the southeast of Iceland, under which is an active volcano. When it erupts, huge volumes of meltwater burst from beneath the ice (forming the floods known as *jokulhlaups*) with massive damage to roads and infrastructure on the sandur outwash plains. Huge quantities of rock debris are transported by the floods and extend the coastline seawards.

Another feature of eruptions beneath ice is the development of tuyas or table mountains. These form in three stages:

- when a volcanic eruption occurs through a vent covered by very thick ice, magma melts the ice to produce a water-filled cavity, and under high pressure pillow lavas are deposited;
- as the volcano grows, the ice/water pressure decreases and further eruptions are phreatomagmatic, with shattered hyaloclastic tephra (mainly fragments of basalt glass) overlying the pillow lavas;
- with further growth the vents may rise above water level, and subaerial effusive flows then build on the piles of subjacent hyaloclastites, thereby creating the distinctive "table top" appearance of the tuya.

The grand terraced waterfall of Gulfoss cascading over ledges of flood basalt, in southeastern Iceland.

Much of Iceland's scenery is dominated by successive, near-horizontal, basaltic lava flows that produce a characteristic trap or staircase morphology with the development of many spectacular waterfalls.

Because of the increased heat flow associated with the mid-ocean ridge, hot springs abound, and at Geysir the eruption of a hot water spout has given its name to other such features worldwide. Wilhem Bunsen, of burner fame, correctly attributed the phenomenon to meteoric water that penetrates to depths where it is heated geothermally, but then ascribed the eruptions to bubbles of high-pressure steam accelerating in their rise towards the surface. In fact, the key process is "flashing" whereby superheated water converts instantly to steam when pressure declines due to water being pushed out of the underground conduit.

The tuya table mountain of Herdubreid, Iceland, with its distinctive tabular profile created by the cap of strong lavas on its pile of hyaloclastites formed by a sub-glacial volcano.

The zeolite minerals

Iceland's basaltic lavas are commonly amygdaloidal, and the cavities are filled with minerals that include calcite, quartz and feldspars and widespread zeolites. These are tectosilicates, with three dimensional frameworks of SiO_4 and AlO_4 tetrahedra, that are characterised by an open crystal structure with channels and cavities that give space for water molecules. On heating, the loosely bound water is given off without structural collapse - hence the name from the Greek for 'boiling stone'. Zeolites are white, colourless or in pale colours, and many occur as handsome fibrous, acicular, tabular or cubic crystals.

[*This presentation was accompanied by a demonstration of zeolites collected from Scotland and Iceland*].

Zeolites from Jeigerhorn, Iceland.

Rise of the Roddons

Dinah Smith

The Fenland of Lincolnshire and Cambridgeshire is the largest area (4000 km^2) of Holocene deposits in Britain. These are up to 15 m thick and have a complex palaeo-environmental history. Their stratigraphy comprises a succession of interbedded clays (marginal marine salt-marsh environments) and peats (freshwater reed beds), representing greater and lesser amounts of marine influence over the time period from 6000 to 2000 BP.

Microfossils in a washed sample of roddon soil.

The salt marsh clays contain spectacular networks of silt/sand-filled tidal creeks known locally as roddons. These can be seen in many fields in the Fens as very slight ridges with paler-coloured soil, and are best seen after the land had been ploughed.

The roddons host a range of microfossils – especially foraminifera, ostracods and the spines and stereome fragments of echinoids. The latter provide firm evidence for the marine origin of the sediments.

By working out the mechanism of the infill that formed these roddons, by analysis of their sediments and microfauna, a greater understanding of the transgressive and regressive history of the Fenland may be determined. Work has been concentrated on the Thorney area of Cambridgeshire with visits to roddons at Whittlesey in Cambridgeshire and Methwold in Norfolk, and environments have been compared with the modern tidal system at Stiffkey on the north Norfolk coast.

Cross-section of a roddon in a ditch beside the new Thorney bypass (at TF316045), showing the paler soil in the clean-cut, U-shaped channel, beneath the gentle ridge of the roddon.

Water Wheels and Geology at Matlock

Lynn Willies

A major feature of the geology of the Matlock Gorge is a series of east-west anticlines and synclines, plunging to the east at the Carboniferous limestone margin with the overlying Edale Shales (Ford, 2002). The River Derwent cuts the gorge through limestone and associated volcanics, in a sinuous course of about 5 km between Matlock and Cromford, The complex river course is derived partly from superimposition from the overlying shale on to the limestone (with the various folds leading to its sinuous course); it then cut down into the limestone, rather than shifting eastwards in the softer shales, where its course was fixed by projecting limestone reef-knolls. Finally there was a uniclinal shift of the course above hard basaltic lavas and in soft volcanic tuffs at the latter's top surfaces.

The area is one of Missippian-type lead/zinc, fluorite/baryte mineralization with associated minerals, especially calcite, in both fissure veins and stratiform pipe deposits (Ford, 2001). Power sites for mine pumping to exploit the mineralisation are found on the River Derwent, and include from north to south, Dimple Mine 300 m north of Matlock centre, Ladygate at the west end of Pic Tor or Church Cliffs, two sites at Artists Corner, two under High Tor, one near Hodgkinson's Hotel Corner, Matlock Bath and the Hagg Mine at the southern end of the Lovers' Walks, Matlock Bath. This list of water wheel locations is not exhaustive and at least another couple of sites are possible. Contemporary evidence of the sites and their function lies in old paintings of this very scenic area.

Dimple Mine is on the major Seven Rakes Vein, with a wheel installed alongside the river in the 1760s; a steam engine was installed about 1808 and another a half-century later. One recent result of the documentary information was a forecast of cavernous sub-river workings above the lava and tuff where the vein cuts through. These were drilled for and found above 20 m depth, and reinforced concrete was laid to protect the new section of railway line above. Little remains to be seen today except for hummocks and cinders at the steam engine site next to the river and the outcrop of the vein in the quarry cliff behind the Sainsbury's recycling site. The top of the vesicular lava and the overlying tuff can be seen near the new River Bridge, but is likely to vegetate fairly soon.

Ladygate has a vein of the same name cutting the river and passing through Pic Tor, which is notable for its adjacent reef knoll and very cherty limestone. A water-colour picture of about 1789, of the timber scaffold bridge which carried the pumping rods over the river, is in the Cornwall Record Office. A steam engine followed, suggesting mining to considerable depth, but little came of it. The deep cleft of the vein is obvious today in the cliff and there are remains of the pumping shaft at its base. The water wheel was over the river, apparently fed by an extended leat from the Dimple site.

Ringing Rake ranges north from Artists Corner, and is a southward extension of the parallel veins that make up Seven Rakes; it continues south, being then known over the river as Raddle Rake, forming the huge fissure behind the main face of High Tor. There is a substantial side of the wheel pit south of the corner on the High Tor side of the river, which dates from about 1800. The other side of the wheel pit was in the river, and the wheel could be hauled up when there were heavy floods. A painting shows a section of the rods which ran a short distance upstream and then crossed the river to work a shaft on Ringing Rake, probably near the present public toilets in the car park. It is fairly certain that the wheel and pumps enabled the workings to go under the river for the first time. It is possible to enter this mine and see the fault, volcanics including hyaloclastites, and a range of other features of geological interest.

Raddle Rake is the continuation of Ringing Rake east of the river and up to High Tor face; a sough entry can be seen a few metres above the south side of the river bank, isolated by river-lowering operations in the 1790s and 1970s. The wheel site was across the river on the west or road side, almost opposite the Ringing Rake site, and again presumably operated by rods over the river and up the hillside to a pumping shaft. It was abandoned by 1789 when a little sketch of it was drawn by Turner.

High Tor Mine, worked about 1820, had a huge wheel, 8 m across and of about 80 HP capacity. The weir and leat are shown on Ordnance Survey large-scale plans, but were destroyed in a flood-relief scheme about 1970. However the wheel site and tail race still exist under the paint works that succeeded the mine by about 1850 and still operate. Rods took the power 300 m along a passage under the Tor following the Great Rake, and there are still holes visible that retained support beams for the pumping rods. The lack of appreciation of the depth the old miners worked below river – probably well over 30 m – was part of the reason for the failure of the Riber Mine in the 1950s.

Stone-lined pit that held a water wheel, dating from around 1800, on the High Tor bank of the River Derwent.

South of High Tor, midway between the above site and Matlock Bath Station, was another small weir, from about 1780, shown on a water colour, while there is also a further picture, possibly by de Loutherberg, that appears to have rods looking rather like a post and rail fence going up to what became the site of the 1950s Riber Mine. The picture location is unknown.

By North Parade, at its western end and near the Jubilee footbridge in Matlock Bath, there was a weir across the river probably in the mid-18th century, again seen in paintings. This was near a sough that went under the Heights of Abraham and the Coalpit and Great rakes, though it is more likely that it fed a leat to a wheel working veins on the east side of the river just around the corner.

Hagg Mine was portrayed by de Loutherberg about 1780. His romanticised picture may be seen in Buxton Museum and shows a rather-too-rustic bridge carrying rods and chains running on pulleys across the river. The mine is still enterable, but it is in very soft slippery tuffs. The river-level sough drained almost a kilometre to just beyond the White Lion at Starkholmes, but it is doubtful whether the lower pumping level ever reached that far. A little sketch made by Eric Geisler, a Swedish traveller in about 1773, shows the wheel and rods; the wheel was undershot, on the west side of the river.

In conclusion, historically the veins have been tested well east of the river and the associated geology has been investigated to reasonable depths. Overall, the evidence is that economic mineralisation is limited to the east, and the presence of volcanics makes mining difficulties because of the associated clays. Appreciation of this might have prevented heavy financial losses at Riber Mine in the 1950s. Knowledge of the cavernous substructure beneath Dimple Mine, still had economic usefulness in railway development. One does not actually need to go out and get tired and dirty to study geology – there is much evidence of economic geology available in archives and galleries. In addition try searching for Matlock Bath pictures on the internet and especially the British Library and Picture the Past collections.

Thanks to Roger Flindall who has supplied much data from his extensive researches, and who also searched parts of the area with me.

References

Ford, Trevor D., 2002. The Geology of the Matlock Mines. *Mercian Geologist*, **15**(3), supplement.

Willies, Lynn, 2001. Water power in Peak District mining. *Mining History*, **15**(4\5), 36-42.

Ardnamurchan Macro to Micro

Rob Gill

Correct identification of rocks by their mineralogy and texture is one of the cornerstones of geology, and the desire to be able to achieve this, prompted by a visit to Montserrat and the collection of some rocks from there, was responsible for the creation of Geosec Slides, a small business producing thin sections on microscope slides. Setting up the business involved a move from Lincolnshire (and the East Midlands Geological Society) to Ardnamurchan in Argyll.

Geosec is now located at Achnaha, in the middle of one of the Tertiary volcanoes on the west coast of Scotland. The area is remote, and the scenery is spectacular, with the ring formation that is known worldwide and remains the subject of active geological debate over its formation. One of the main reasons for being in this area is the range of different rock types available nearby for study. The feeling of being within a volcanic structure is more obvious here than in most of the other centres in the Scottish volcanic province; the topography of many others has been modified by ice, to produce a landscape that is more post-glacial than volcanic.

It is not too difficult for anyone with an interest to make thin sections for their own study. Modern cements are easier to use than the traditional Canada balsam; clear epoxy resin, sold for glass and china repair, is fine for cementing the sample to the slide, and UV-setting superglue can be used for fixing the coverslip. Grinding is done on a glass plate with 220- and 400-grade silicon carbide grit, and slicing is with a diamond saw, either a lapidary model or even one of a tile-cutter type. Many rocks, of only moderate attractiveness in hand sample, become objects of beauty when viewed in polarised light; spectacular birefringence colours are displayed, and the structure and mineralogy are revealed, leading to easier correct identification.

Ardnamurchan's Tertiary ring complex, seen from the west.